To :

This specification is only used for discussing the included items.
You haven't to approve this specification.
When we shall agree the specification, we will issue the formal one.

SPECIFICATION(TENTATIVE)

FOR

Toshiba Matsushita Display Technology TFT-LCD MODULE

LTA170C07RF

LTA170C07RF-01

DATE OF ISSUE : 2003-06-18

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Revision History

Date	Sheet (New)	Item	Old	New	Reason
’03-6-18	NEW	TENTATIVE SPECIFICATIONS	-	-	-

Caution and Handling Precaution

For your end users' safety, it is strongly advised that the items with "＊" should be included in the instruction manual of the system which may be issued by your organization.

For Safety

⚠ Warning

1) SPECIAL PURPOSES

a) Toshiba Matsushita Display Technology's Standard LCD modules have not been customized for operation in extreme environments or for use in applications where performance failures could be life-threatening or otherwise catastrophic.

b) Since they have not been designed for operation in extreme environments, they must never be used in devices that will be exposed to temperatures above 50 degrees Celsius or below 0 degrees Celsius, to X-ray or Gamma-ray radiation, or to abnormally high levels of vibration or shock which exceed Toshiba Matsushita Display Technology's specification limits.

c) In addition, since Toshiba Matsushita Display Technology's Standard LCD modules have not been designed for use in applications where performance failures could be life-threatening of catastrophic, they must never be installed in aircraft navigation control systems (such as, but not limited to Traffic Collision Avoidance System and Air Traffic Indicator), in military defense or weapons systems, in critical industrial process-control systems (e.g., those involved in the production of nuclear energy), or in critical medical device or patient life-support systems.

2) ELECTRIC SHOCK

DISCONNECT POWER SUPPLY before handling LCD modules. In order to prevent electric shock, DO NOT TOUCH the electrode part, cables, connectors, and the fluorescent lamp's (hereinafter called "FL") circuit part of a module in which FL tubes are built in as a light source of a backlight or a front light. High voltage is supplied to these parts while power supply is turned on.

3) FL CABLE CONNECTION

Make sure to insert the module FL connector to the inverter connector in correct position and correct polarity. If incorrect, this may cause smoke or burn of electrical parts by high voltage of FL circuit. If there is a possibility that the connector has been inserted incorrectly, re-insert the connector only after you confirm the module and FL power is completely off. When disconnecting the connector, do not pull on the cable.

DO NOT USE the mating FL connector which Toshiba Matsushita Display Technology does not specify. Otherwise, Toshiba Matsushita Display Technology shall not be liable for any damages caused by the connector.

⚠ Caution

1) ＊ DISASSEMBLING OR MODIFICATION

DO NOT DISASSEMBLE OR MODIFY the modules.

Sensitive parts inside LCD module may be damaged, and dusts or scratches may mar the displays. Toshiba Matsushita Display Technology does not warrant the modules, if customer disassembled or modified them.

2) ＊ BREAKAGE OF LCD PANEL

DO NOT INGEST liquid crystal material, DO NOT INHALE this material, and DO NOT PERMIT this material to contact the skin, if glass of LCD panel is broken.

If liquid crystal material contacts the skin, mouth or clothing, take the following actions immediately.

In case contact to the eye or mouth, rinse with large amount of running water for more than 15 minutes. In case contact to the skin or clothing, wipe it off immediately and wash with soap and large amount of running water for more than 15 minutes. The skin or closing may be damaged if liquid crystal material is left adhered.

In case ingestion, rinse out the mouth well with water. After spewing up by drinking large amount of water, get medical treatment.

3) ＊ GLASS OF LCD PANEL

BE CAREFUL WITH CHIPS OF GRASS that may cause injuring fingers or skin, when the glass is broken.

Since FL is also made of glass, when FL is built in, handle it with due caution as well.

4) ABSOLUTE MAXIMUM RATINGS

DO NOT EXCEED the absolute maximum rating values under the worst probable conditions caused by the supply voltage variation, input voltage variation, variation in parts' constants, environmental temperature, etc., otherwise LCD module may be damaged.

5) POWER PROTECTION CIRCUIT

Employ protection circuit for power supply, whenever the specification specifies it.

A suitable protection circuit should be applied, based on each system design.

6) DISPOSAL

Always comply all applicable environmental regulations, when disposing of LCD module.

7) EDGES OF PARTS

Be careful with handling the metal flame (bezel) of a module. Even though burr disposal treatment is performed, it may cause injuring. Be careful with edges of glass parts and touch panel identically. For designing the system, give special consideration that the wiring and parts do not touch those edges.

8) ＊ LUMINANCE DECREASE OF FL

When FL becomes extremely dark and its color changes from white to pink, stop the use of the module immediately. FL, at the end of its life with its discharge color turns into pink as the characteristics of FL, may adversely affect the module at the end part of FL due to temperature raising caused by depletion of the mercury which is contained in FL tube, or may have a possibility of breakage.

For Designing the System

2-1 DESIGNING ENCLOSURE

1) MECHANICAL DIMENSIONS

Refer to the individual specification for LCD module's mechanical dimensions.

2) MOUNTING HOLES

LCD module should be assembled to the system by using all mounting holes specified in the individual specification with the specified screws.

In addition, some modules may not be necessary to use all the mounting holes. Make comprehensive judgments on the entire system.

3) ＊ BENDING / TWISTING

Make sure to design the enclosure that bending/twisting forces are not applied to LCD module during and after the installation into the system.

4) GASES FROM SETTING MATERIAL

Some plastic materials and shock absorbing materials (rubber) used in the system may generate gases that may cause the deterioration of the polarizer laminated on LCD's panel or internal parts of the module. Prior confirmation is required.

5) GASES FROM PACKAGING MATERIAL

Some materials used for packaging (for which sulfuric acid is used in the recycling process) generate gases that may cause the deterioration of the polarizer laminated on LCD's panel or internal parts of the module. Prior confirmation is required.

2-2 DESIGNING POWER SUPPLIES AND INPUT SIGNALS TO LCD MODULE

1) CAPACITY OF POWER SUPPLY

Refer to individual specification for details for capacity of power supply, and apply some protection circuit including fuses for power supply lines.

2) SEQUENCE OF POWER SUPPLIES AND INPUT SIGNALS

Power supply lines should be designed as follows.

Power supplies should always be turned on before the input signals are applied to LCD module, and the input signals should be disconnected before power supplies are turned off.

The detailed sequence of power supplies and signals are described in the individual specification.

In addition, refer to individual specifications for unused terminals.

3) FL CABLE CONNECTION

Make sure to connect correctly high-voltage wire and low-voltage wire between FL tube and inverter unit.

If high-voltage wire and low-voltage wire are connected incorrectly, it may cause insufficient brightness or unstable operation of FL, and smoke or burn of the parts.

4) PREVENTION OF IMAGE STICKING

Design the system not to display same pattern for a long time in order to prevent image sticking on the panel. Note that incorrect sequence of power supplies and input signals may cause the sticking on the panel, too.

5) GROUNDING OF METAL FRAME

Grounding of metal frame of LCD module is generally effective to prevent radiation interference from the system design.

However, the necessity of grounding, or effective grounding method should be dependent on each system design.

2-3 DESIGNING FOR BETTER VISIBILITY

1) PANEL ANGLE

Visibility of LCD module deeply depends on the viewing directions. The position and the angle of LCD module in the system should be designed so that the best visibility can be obtained at the actual usage.

2) WINDOW OPENING

Dimensions of window opening of the system's enclosure should be designed as smaller than "Viewing Area" and larger than "Active Area" specified in individual specification in order to obtain better appearance.

3) PROTECTIVE COVER

In case of severe environmental condition like outdoor usage, a proper transparent protective cover(lens) over LCD module is recommended to apply in order to prevent scratches, and invasion of dust, water, etc., from the system's window onto LCD module.

Ultra-violet ray cut filter is recommended to apply onto LCD module for outdoor operation. Strong ultra-violet ray may cause damage the panel. However, in that case, transmittance-luminance will decrease. Careful selection of material is required.

2-4 DESIGNING FL POWER SUPPLY CIRCUIT

Input FL starting voltage(VSFL) should be longer than two seconds. If it were not, it may cause unstable operation of FL.

Inverter should be design to stop output when the inverter is no-load to FL tubes (due to breakage of FL, etc.) to prevent high-voltage generation.

When high voltage is applied to FL continuously without normal operation of FL (due to output leakage within FL wiring circuit, etc.) it may cause smoke or burn. To prevent excess current, design the inverter with a protection circuit such as a current limiter (excess current detection) to stop inverter output.

For Installation in Assembly

3-1 ESD (ELECTRO-STATIC DISCHARGE) PREVENTION

The C-MOS LSIs used in LCD module is very sensitive to ESD. The following caution should be taken when installing LCD module to an enclosure of the system in order to prevent damage of C-MOS LSIs used in LCD module.

1) HUMIDITY

Ambient humidity of working area is recommended to be higher than 50%RH in order to avoid ESD.

2) GROUNDING

2-1) Grounded electro-conductive mats are recommended to be covered on the floor of working area and surface of working benches.

2-2) The grounding should be done through a resister of 0.5-1M ohms in order to prevent spark of ESD.

2-3) Person handling LCD modules should be grounded with wrist band.
2-4) Tools like soldering iron and screw drivers and working benches should be grounded.

3) IONIZER
Using ionizer (an antistatic blower) is recommended at working area in order to reduce electro-static voltage.

4) REMOVING PROTECTION FILM
When removing protection film from LCD panel, peel off the film slowly (more than three seconds) from the edge of the panel with round-ended tweezers or adhesive tape while blowing with ionizer toward the peeling face to minimize ESD which may damage electrical circuit.

5) Be careful with touching metal portion of testing instruments in order to prevent unnecessary ESD.

6) Do not touch the electrode area of PCB and electrical parts like LSI, capacitor, connector pin, etc.

3-2 DUST AND STAIN PREVENTION
1) WORKING AREA
Reduce dust level in working area. Especially the level of metal particle should be decreased, otherwise electrical circuit in LCD module may be damaged due to short circuit by metal particles.

2) PROTECTION FILM
LCD module may be shipped with "protection film" on LCD panel in order to prevent from scratches and dust.
It is recommended to remove the film at later process of assembling.

3) FINGER PRINT
Use finger stalls or soft and dust-free gloves in order to keep clean appearance of LCD module when handled for incoming inspection and assembly.

4) ＊ WIPING OFF DUST ON THE PANEL
When LCD panel becomes dirty, wipe the panel surface off softly with absorbent cotton or another soft cloth.
If necessary, breathe upon the panel surface and then wipe off immediately and softly again.
If the dirt can not be wiped off, follow the instructions described in individual specification.
Be careful not to spill organic solvents into the inside of LCD module. The solvents may damage driver IC and PCB area used inside module.
The polarizer laminated to LCD panel and adhesives may be damaged by the solvents, so do not use any organic solvents for wiping off LCD panel.

5) ADHESIVE ON LCD PANEL
Be careful not to attach adhesive, grease, etc., on LCD panel, because it is difficult to remove them without any damages on LCD panel.

6) ＊ WATER SPOTS ON THE PANEL

Avoid the dewing or water condensation.

Wipe off a spot or spots of water or mist on LCD panel softly with absorbent cotton or another cloth as soon as possible if happened, otherwise discoloration or stain may be caused.

3-3 BENDING / TWISTING OF LCD MODULE DURING ASSEMBLY

1) INSTALLING LCD MODULE TO THE ENCLOSURE

Do not bend or twist LCD module even momentary when LCD module is installed into an enclosure of the system.

2) FASTENING SCREWS

Fasten screws for mounting holes uniformly, otherwise bending / twisting force may be applied to LCD module.

3) INTERFACE / FL CABLES

Do not fasten screws, with catching interface cables or FL cables between LCD module and the enclosure. This may cause bending of LCD module, or become the cause of a failure by damaging cables.

3-4 MECHANICAL FORCES

1) ＊ STRONG MECHANICAL SHOCK

Refrain from strong mechanical shock like dropping from the working bench or knocking against hard object.

These may cause panel crack, damage of FL or other mis-operation.

2) ＊ EXCESSIVE FORCE

Refrain from excessive force like pushing the surface of LCD panel. This may cause scratches or breakage of the panel, or a failure of the module.

3) ＊ SCRATCHES ON THE PANEL

Do not put heavy object such as tools, books, etc., and do not pile up LCD modules.

Be careful not to touch surface of the polarizer laminated to the panel with any hard and sharp object. The polarizer is so soft that it can be easily scratched, even the protect film covers it.

4) CONNECTORS

When inserting or disconnecting the connectors to LCD module, be sure not to apply force against PCB nor connecting cables, otherwise internal connection of PCB and TAB drivers may be damaged.

5) FL CABLES

Be careful not to pull the FL cables in order to avoid mechanical damage in FL lamp and soldering area.

While mounting, do not bind or twist the FL cables, or the Lamp current may not be applied as designed.

3-5 OPERATION

Be sure that the following caution should be taken under assembly and inspection of the system.

1) POWER SUPPLY

Power supplies should always be turned off in connecting process.

Do not connect or disconnect the power cables and connectors with power applied to LCD module.

2) INPUT SIGNAL

The signal should be applied after power supplies are turned on.

The signal should be removed before power supplies are turned off.

The detailed sequence of power supplies and signals are described in individual specifications.

For Transportation and Storage

1) TEMPERATURE

Do not store LCD modules in high temperature, especially in high humidity for a long time (approximately more than one month).

It is strongly recommended to store LCD modules where the temperature is in the range of 0 to 35 degrees Celsius and the humidity is lower than 70%.

2) LOW TEMPERATURE

Liquid crystal material may be coagulated and LCD panel may be damaged at the lower temperature than storage temperature range described in individual specification.

3) ULTRA VIOLET RAY

Store LCD module without exposure to direct sunlight or fluorescent lamps in order to prevent the module from strong ultra violet ray.

4) CLEANLINESS

Keep the module in clean place, because any dust, hard particle may damage the polarizer, or dust invades the inside of the module.

5) ＊ CONDENSATION OF WATER

Avoid condensation of water on LCD module, otherwise it may cause mis-operation or defects. Keep away LCD module from such ambient.

6) PACKAGING

In case of transportation or storage after opening the original packaging, LCD modules are recommended to be repacked into the original packaging with the same method, especially with same kind of desiccant.

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1. Scope

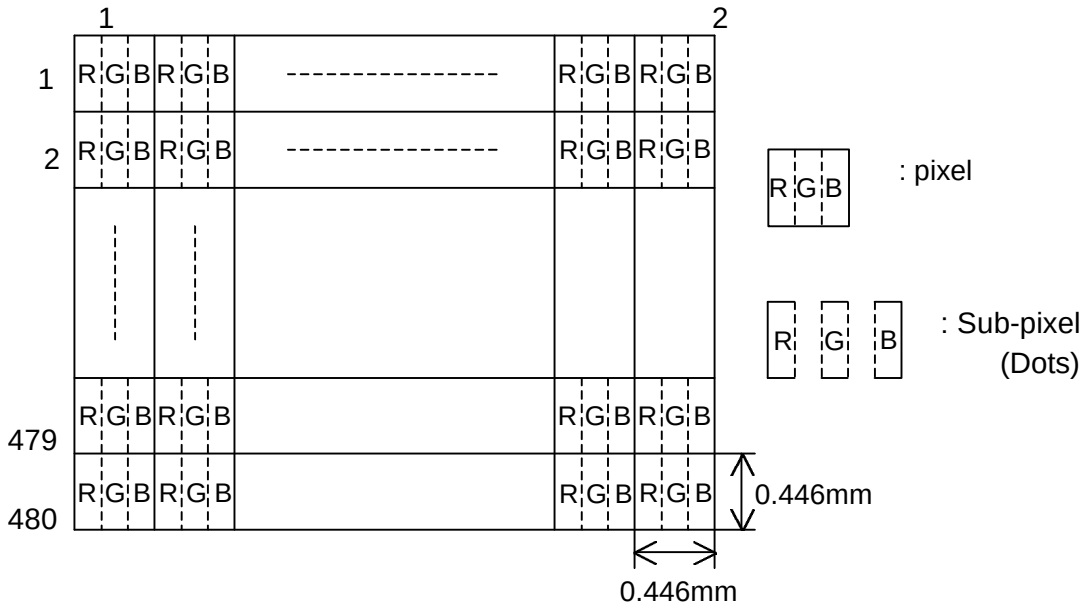
This specification is applicable to Toshiba Matsushita Display Technology's 43 cm diagonal size TFT-LCD module "LTA170C07RF" designed for TV.

2. Product Specifications

2.1 General Specifications

Item	Specifications
Display Mode	TN color (253 gray scales, 16,194,277 colors) Transmissive type, Normally white
Viewing Direction	6 o'clock (in direction of maximum contrast)
Driving Method	TFT active matrix
Input Signals	C-MOS 8Bit × RGB
Dimensional Outline	385 (*W*) × 303 (*H*) × 17.5 (*D*) (mm)
Active Area	343.68 (*W*) × 261.60 (*H*) (mm)
Viewing Area	349 (*W*) × 267 (*H*) (mm)
Number of Pixels	640 (*W*) × 480 (*H*) [1)]
Pixel Pitch	0.545 (*W*) × 0.537 (*H*) (mm) [1)]
Pixel Arrangement	RGB vertical stripes [1)]
Surface Treatment	Low Reflection & Anti-glare hard coat on LCD surface
Backlight	4 cold-cathode fluorescent lamps (L-Type)

Note 1) Display area address is as follows.



2.2 Absolute Maximum Ratings [1)]

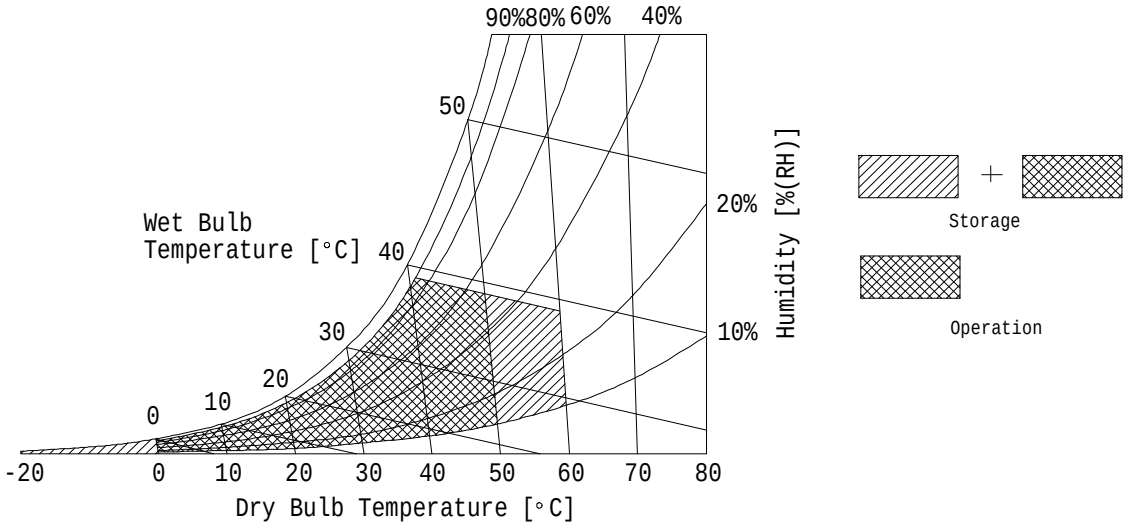
Item	Symbol	Min.	Max.	Unit	Checked Terminal [4)]
Supply Voltage	V_{DD}	-0.3	+6.0	V	V_{DD} - GND
Input Voltage of Signals	V_{IN}	-0.3	V_{DD}+0.3	V	
FL Driving Voltage	V_{FL}	0	2.0	kV(rms)	
FL Driving Frequency	f_{FL}	0	100	kHz	
Operating Ambient Temperature [2)]	T_{OP}	0	+50	°C	
Operating Ambient Humidity [2)]	H_{OP}	10	90	%(RH)	
Storage Temperature [2)]	T_{STG}	-20	+60	°C	
Storage Humidity [2)]	H_{STG}	10	90	%(RH)	
Operating Temperature for Panel [3)]	-	0	+60	°C	

Note 1) Do not exceed the maximum rating values under the worst probable conditions taking into account the supply voltage variation, input voltage variation, variation in part constants, and ambient temperature and so on. Otherwise the module may be damaged.

2) Wet bulb temperature should be 39°C (Max), and no condensation of water. See figure below.

3) The surface temperature caused by self heat radiation of cell itself is specified on this item.

4) Refer to 2.4.5



2.3 Mechanical Specifications

2.3.1 Weight

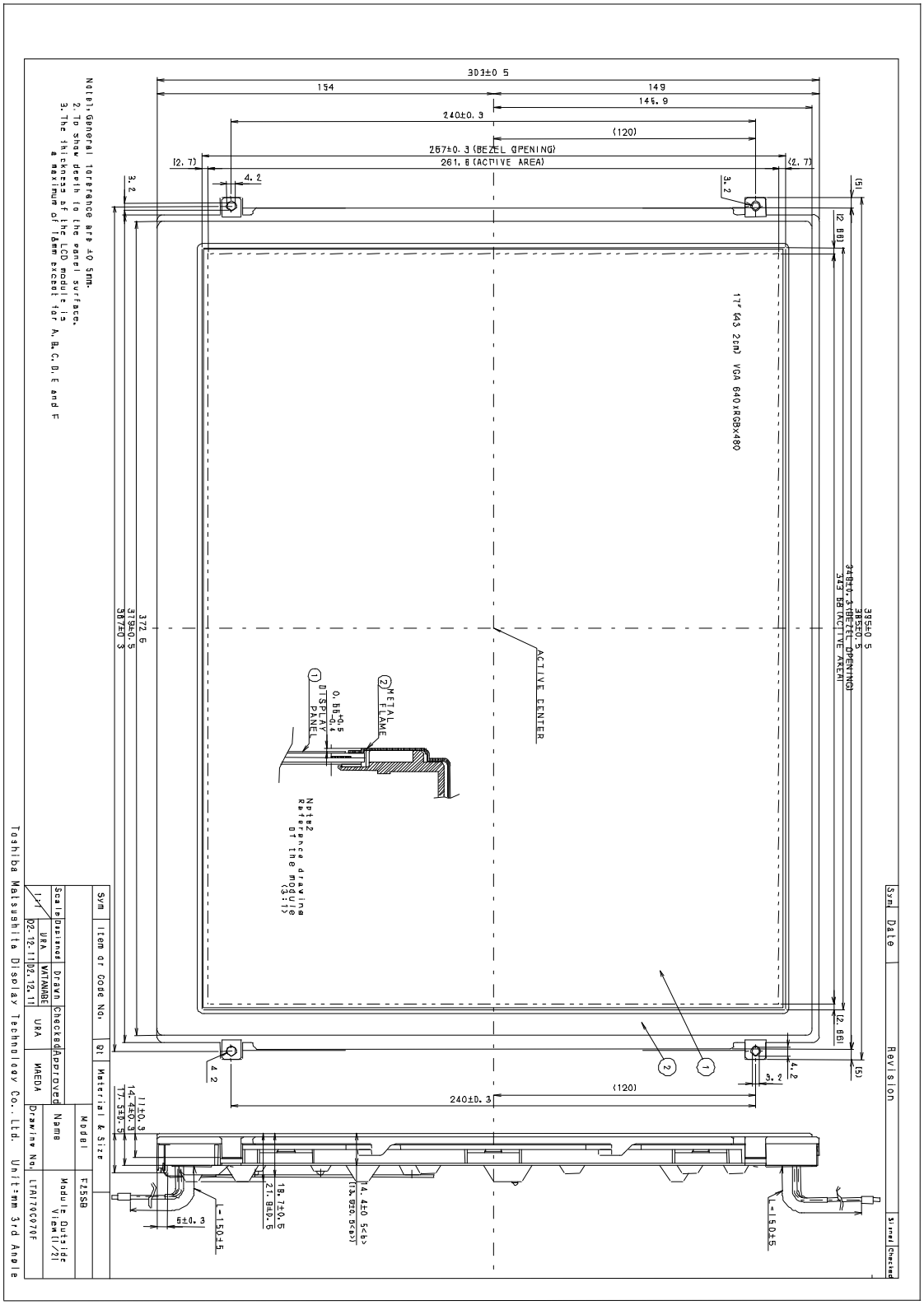
2000 ± 100g

2.3.2 Dimensional Outline

(Front figure)

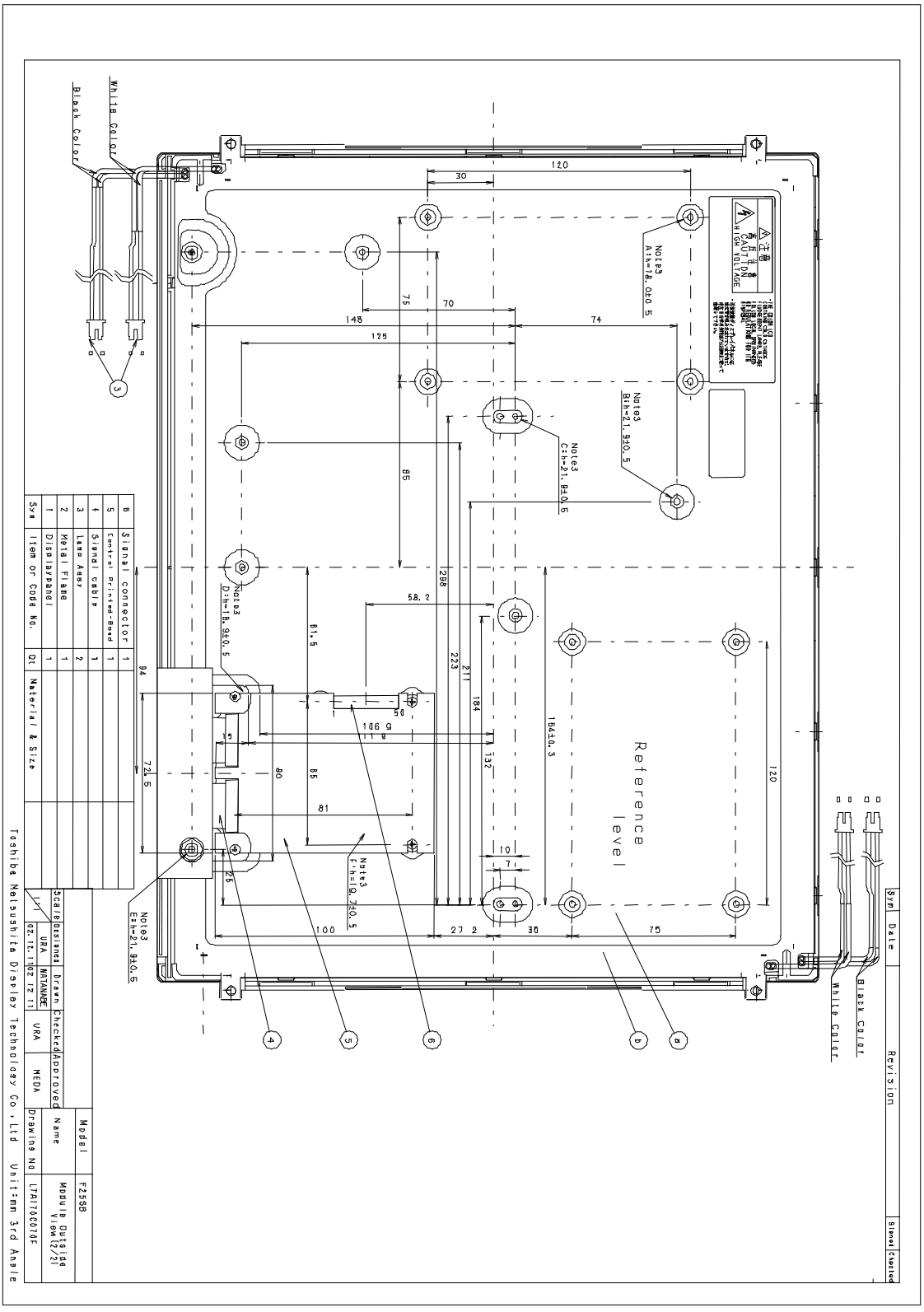
Unit: mm

Standard Tolerance: 0.5



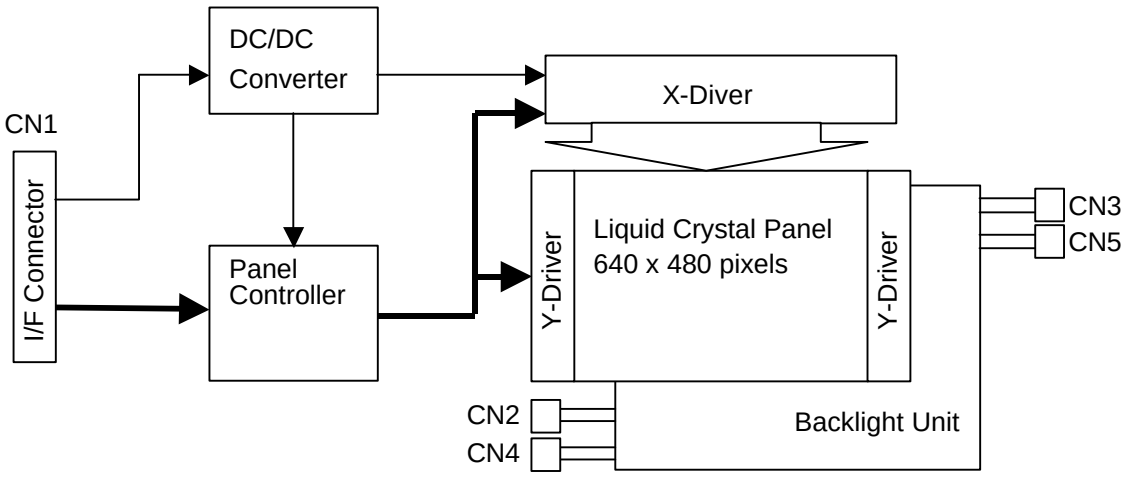
(Back figure)

Unit: mm
Standard Tolerance: 0.5

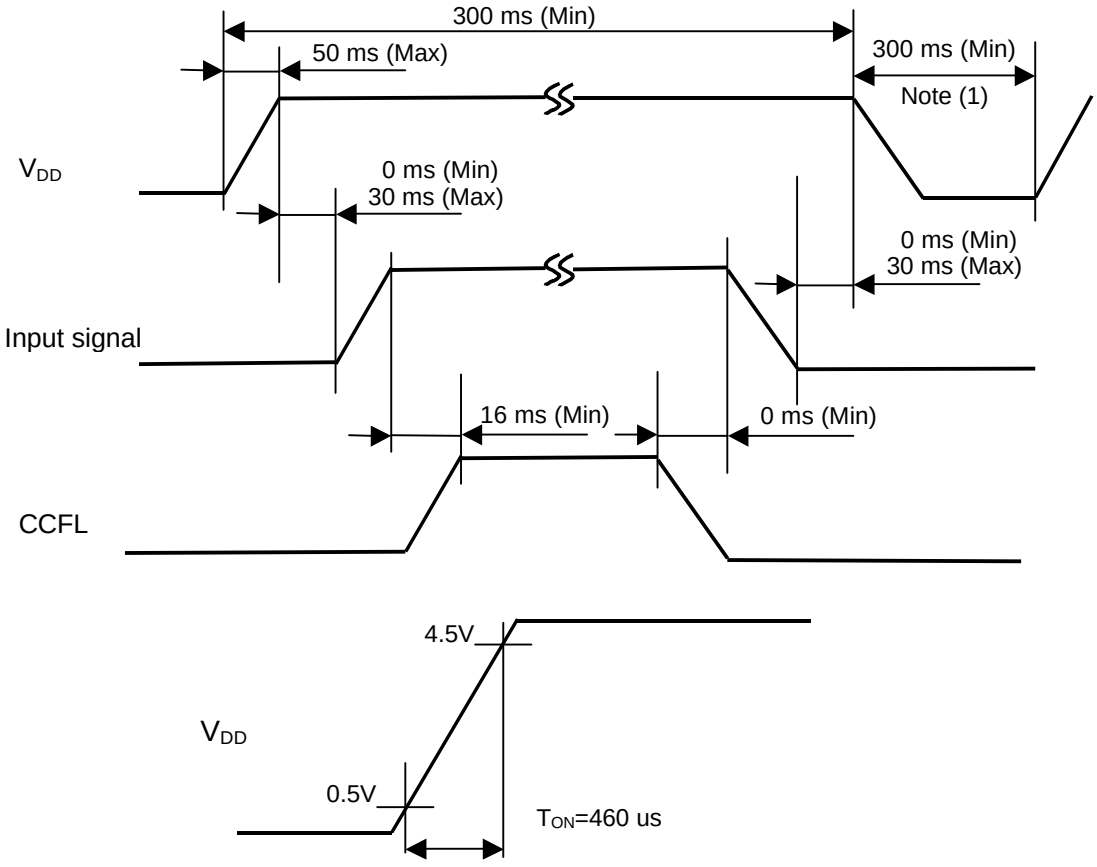


2.4 Electrical Specifications

2.4.1 Circuit Diagram

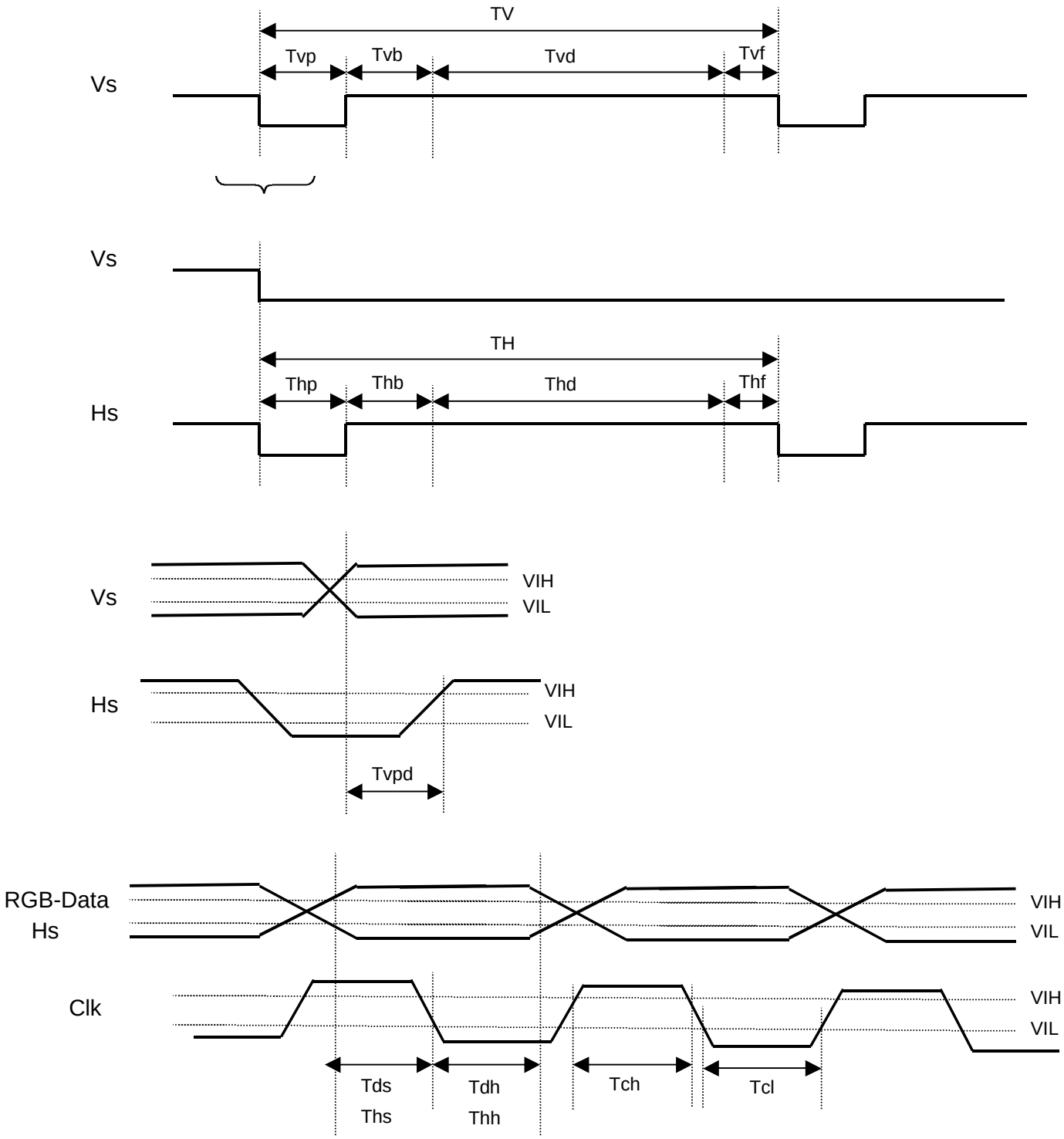


2.4.2 Sequence of Power Supplies and Signals



Note (1): OFF time (<=0.5V) should be maintained more than 150ms.

2.4.3 Timing Chart



2.4.4 Timing Specifications [1) 2) 3) 4)]

Item		Symbol	Min.	Typ.	Max.	Unit	Remarks
Clock (Clk)	Frequency	Fck	17	28.6	31.5	MHz	
	High time	Tch	10	-	-	nsec	
	Low time	Tcl	10	-	-	nsec	
DATA	Setup time	Tds	6	-	-	nsec	
	Hold time	Tdh	7	-	-	nsec	
Horizontal (Hs)	Polarity	-		Negative		-	
	Setup time	Ths	6	-	-	nsec	
	Hold time	Thh	7	-	-	nsec	
	Total Period including Blanking	TH	720	910	1620	Fck	
			28.8	31.8	-	µsec	
	Pulse width	Thp	1	69	Note 1	Fck	
	Back porch	Thb	12	104	Note 1	Fck	
	Display term	Thd		640		Fck	
	Front porch	Thf	1	46	-	Fck	
Vertical (Vs)	Polarity	-		Negative		-	
	Phase shift	Tvpd	-1	0	1	Fck	
	Frame Period including Blanking	TV	485	525	720	TH	
			-	16.7	20.0	msec	
	Pulse width	Tvp	1	6	Note 1	TH	
	Back porch	Tvb	2	46	Note 1	TH	
	Front porch	Tvf	1	29	-	TH	
	Display term	Tvd		480		TH	

Note 1) Thp + Thb<254, Tvp + Tvb<254

Note 2) If Hs and Vs signal is fixed to "H" or "L" level for certain period while Clock is supplied, the panel displays black with some flicker.

Note 3) If Clock is fixed to "H" or "L" level for certain period while Hs and Vs is supplied, the panel may be damaged.

Note 4) Please adjust LCD operating signal timing and FL driving frequency, to optimize the display quality.
There is a possibility that flicker is observed by the interference of LCD operating signal timing and FL driving condition (especially driving frequency), even if the condition satisfies above timing specifications and recommended operating conditions shown in 3.

Note5) Do not make TH and TV fluctuate.
If TH and TV are fluctuate, the panel displays error.

Note6) In case of using the long frame period, the deterioration of display quality, noise etc. may be occurred.

Note7) Clock count of each Horizontal Scanning Time should be always the same.
V-Blanking period should be “*n*” X “Horizontal Scanning Time”. (*n*: integer)
Frame period should be always the same.

2.4.5 Interface Connector

CN1 INPUT SIGNAL

Connector : IL-FHR-BF50S-HF / JAE
Mating Connector : TBD / JAE

Terminal No.	Symbol	Function
1	GND	
2	Clk	Clock
3	GND	
4	Vs	Vertical Sync.
5	Hs	Horizontal Sync.
6 1)	NC	
7	GND	
8	R0	Red Display Data 0 (LSB)
9	R1	Red Display Data 1
10	R2	Red Display Data 2
11	R3	Red Display Data 3
12	GND	
13	R4	Red Display Data 4
14	R5	Red Display Data 5
15	R6	Red Display Data 6
16	R7	Red Display Data 7 (MSB)
17	GND	
18	G0	Green Display Data 0 (LSB)
19	G1	Green Display Data 1
20	G2	Green Display Data 2
21	G3	Green Display Data 3
22	GND	
23	G4	Green Display Data 4
24	G5	Green Display Data 5
25	G6	Green Display Data 6
26	G7	Green Display Data 7 (MSB)
27	GND	
28	B0	Blue Display Data 0 (LSB)
29	B1	Blue Display Data 1
30	B2	Blue Display Data 2
31	B3	Blue Display Data 3
32	GND	
33	B4	Blue Display Data 4
34	B5	Blue Display Data 5
35	B6	Blue Display Data 6
36	B7	Blue Display Data 7 (MSB)
37	GND	
38	GND	
39	REGEN	After I^2C data input, it is supplied to 2^{nd} register at internal V-latch signal by “H”-level of this pin input during 1Vs period.
40 2)	INV	Input Data Inversion Control: GND: normal, VDD: Data Inversion
41 2)	GND	
42 2)	SCL	I^2C Clock
43 2)	SDA	I^2C Data
44	V_{DD}	Power Supply : +5.0V
45	V_{DD}	Power Supply : +5.0V
46	V_{DD}	Power Supply : +5.0V
47	V_{DD}	Power Supply : +5.0V
48 1)	NC	
49 1)	NC	
50	GND	

Note 1) NC terminal should be open.
Note 2) In case of using 6bit input data, please use higher 6bit (bit7-bit2).
In this case, it is recommended to fix bit0 and bit1 on GND.

CN2, 3, 4, 5 CCFL POWER SOURCE

Connector: BHSR-02VS-1 / JAPAN SOLDERLESS TERMINAL MFG CO., LTD.
Mating Connector: SM02B-BHSS-1 / JAPAN SOLDERLESS TERMINAL MFG CO., LTD.

Terminal No.	Symbol	Function
1	V_{FLH}	CCFL Power Supply (high voltage)
2	V_{FLL}	CCFL Power Supply (low voltage)

2.4.6 I²C Register Map

Sub Address		Data								Contents	Initial Value	
		b7	b6	b5	b4	b3	b2	b1	b0		normal	wide
0	00	STH ADDRESS (7:0)								Horizontal start position spec. (CLK)	10110101	10111100
1	01	STV ADDRESS (7:0)								Vertical start position spec. (Hs)	00110010	00101000
2	02	CTL Setup all (7:4)				OEV Hold (3:0)				CTL Setup all: CTL ON Phase setup	00101100	00101001
										OEV Hold: Gate ON Width setup		
3	03	CTL Width (7:0)								CTL Width: CTL ON Width setup	00110101	00110010
4	04	OEV Setup (7:4)				CKV Setup (3:0)				OEV Setup: Gate ON Phase setup	01100110	
										CKV Setup: Gate ON Clock Phase setup		
5	05	R INTEND (7:0)								R INTEND: Souce scan Interval setup	00010111	00110011
6	06			TVD SEL	CENT ON	Inite State OFF	DI OFF	UD	LR	DI OFF: DI stop 0: DI=ON, 1: DI=OFF	00000000	
										UD: Up/Down Reversal 0:Up, 1: Reversal		
										LR: Right/Left Reversal 0:Right, 1: Reversal		
										Inite State OFF: 0:normal, 1: Inite State OFF		
7	07	For Black Belt CTL Width (7:0)								Sausce signal output time in centering mode	00110101	
8	08	STOP Signal Control (7:0)								Timing control for V Blancking's gate voltage	11010110	
9	09			Black Line FRC Level		Black Line Level				Black Line FRC Level: Black line level control by 1/256 Gray scale setp	00000000	
										Black Line Level: control of center Gray Scale		
12	0C	H Start Position				H: End Position				H Start Position: Horizontal start Position adjustment for internal patter (setup X 64)	00100100	
										H end Position: Horizontal end Position adjustment for internal patter (setup X 64)		
13	0D	V: Start Position				V: End Position				V Start Position: Vertical start Position adjustment for internal patter (setup X 64)	00100100	
										V end Position: Vertical end Position adjustment for internal patter (setup X 64)		
14	0E	R ON	G ON	B ON	Win ON	SIG SEL (3:0)				R_ON: R signal control 0:R=L, 1: R=input value	11100000	
										G_ON: G signal control 0:G=L, 1: G=input value		
										B_ON: B signal control 0:B=L, 1: B=input value		
										Win_ON: Display window control for internal pattern 0: No-window, 1: Window		
										SIG_SEL: Internal patten select		
15	0F	SIG LEVEL								Gray scale level control for internal pattern, and Black level contorol	10000000	
16	10	DIN 0p (7:0)								Gamma REF setup (0, R)	00000000	
17	11	DIN 32p (7:0)								Gamma REF setup (32, R)	00110011	
18	12	DIN 64p (7:0)								Gamma REF setup (64, R)	01100000	
19	13	DIN 96p (7:0)								Gamma REF setup (96, R)	10000100	
20	14	DIN 128p (7:0)								Gamma REF setup (128, R)	10100000	
21	15	DIN 160p (7:0)								Gamma REF setup (160, R)	10110110	
22	16	DIN 192p (7:0)								Gamma REF setup (192, R)	11000111	
23	17	DIN 224p (7:0)								Gamma REF setup (224, R)	11011000	
24	18	DIN 256p (7:0)								Gamma REF setup (256, R) (LSB7Bit:validity)	01110011	
25	19	R_Gm th	R_Gm Offset (6:0)							R_Gm_th: R_Gamma Through 0: Through, 1:ON	10000000	
										R_Gm_Offset: R_Gamma offset setup		
26	1A	DIN 0p (7:0)								Gamma GEF setup (0, G)	00000000	
27	1B	DIN 32p (7:0)								Gamma GEF setup (32, G)	00110011	
28	1C	DIN 64p (7:0)								Gamma GEF setup (64, G)	01100000	
29	1D	DIN 96p (7:0)								Gamma GEF setup (96, G)	10000100	
30	1E	DIN 128p (7:0)								Gamma GEF setup (128, G)	10100000	
31	1F	DIN 160p (7:0)								Gamma GEF setup (160, G)	10110110	
32	20	DIN 192p (7:0)								Gamma GEF setup (192, G)	11000111	
33	21	DIN 224p (7:0)								Gamma GEF setup (224, G)	11011000	
34	22	DIN 256p (7:0)								Gamma GEF setup (256, G) (LSB7Bit:validity)	01110011	
35	23	G_Gm th	G_Gm Offset (6:0)							G_Gm_th: G_Gamma Through 0: Through, 1:ON	10000000	
										G_Gm_Offset: G_Gamma offset setup		
36	24	DIN 0p (7:0)								Gamma BEF setup (0, B)	00000000	

37	25	DIN 32p (7:0)								Gamma BEF setup (32, B)	00110011
38	26	DIN 64p (7:0)								Gamma BEF setup (64, B)	01100000
39	27	DIN 96p (7:0)								Gamma BEF setup (96, B)	10000100
40	28	DIN 128p (7:0)								Gamma BEF setup (128, B)	10100000
41	29	DIN 160p (7:0)								Gamma BEF setup (160, B)	10110110
42	2A	DIN 192p (7:0)								Gamma BEF setup (192, B)	11000111
43	2B	DIN 224p (7:0)								Gamma BEF setup (224, B)	11011000
44	2C	DIN 256p (7:0)								Gamma BEF setup (256, B) (LSB7Bit:validity)	01110011
45	2D	B_Gm th	B_Gm Offset (6:0)							B_Gm_th: B_Gamma Through 0: Through, 1:ON	10000000
										B_Gm_Offset: B_Gamma offset setup	
46	2E	Rdc	8Bit 6Bit	Rdm	NS DZ				Sig SEL ON	Rdc: EMI Function On/Off (Reduce) 0: OFF, 1: ON	11000000
										8Bit/6Bit: FRC Function On/Off 0: OFF, 1: ON	
										Rdm: Noise shape random setup 0: Random, 1: Fix	
										NS_DZ: FRC Mode setup 0: NS, 1:4Frame dither	
										Sig SEL ON: Input signal select 0: Imput, 1: Internal	
47	2F	VREF_Offset (7:0)								Reference input for Gamma-Test	00000000

2.4.7 Colors Combination Table

	Display	R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0	Gray Scale Level
Basic Color	Black	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	-
	Blue	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	-
	Green	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	-
	Light Blue	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	-
	Red	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	-
	Purple	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	-
	Yellow	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	-
	White	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	-
Gray Scale of Red	Black	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L 0
	Dark ↑ ↓ Light	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L 0
		L	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L 0
		L	L	L	L	L	L	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L 0
		L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L 4
		:								:								:								L5… L252
		H	H	H	H	H	H	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L253
		H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L254
	Red	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	Red L255
Gray Scale of Green	Black	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L 0
	Dark ↑ ↓ Light	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L 0
		L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L 0
		L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	L	L	L	L	L	L	L	L	L 0
		L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L 4
		:								:								:								L5… L252
		L	L	L	L	L	L	L	L	H	H	H	H	H	H	L	H	L	L	L	L	L	L	L	L	L253
		L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L254
	Green	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	Green L255
Gray Scale of Blue	Black	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L 0
	Dark ↑ ↓ Light	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L 0
		L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L 0
		L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	L 0
		L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L 4
		:								:								:								L5… L252
		L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	L	H	L243
		L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	L	L254
	Blue	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	Blue L255
Gray Scale of White & Black	Black	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L 0
	Dark ↑ ↓ Light	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	H	L 0
		L	L	L	L	L	L	H	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	H	L	L 0
		L	L	L	L	L	L	H	H	L	L	L	L	L	L	H	H	L	L	L	L	L	L	H	H	L 0
		L	L	L	L	L	H	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	H	L	L	L 4
		:								:								:								L5… L252
		H	H	H	H	H	H	L	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H	L	H	L253
		H	H	H	H	H	H	H	L	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H	L	L254
	White	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	White L255

Note1 L: Low level voltage, H: High level voltage

3. Recommended Operating Conditions [1) 5) 6)]

Item		Min.	Typ.	Max.	Unit	Remarks
Supply Voltage	V_{DD}	4.75	5.0	5.25	V	2)
Current Consumption	I_{DD} *2	-	190	270	mA(rms)	
Inrush current	I_{RS} *3	-	-	2100	mA(peak)	
Allowable Ripple Voltage	V_{RP}	-	-	100	mV(p-p)	
FL Driving Voltage	V_{FL}	909	1010	1111	V(rms)	I_{FL}=(6.0)mA(rms) 9)
FL Start Voltage		-	-	2150	V(rms)	Ta=0 °C 9)11)
FL Driving Frequency	f_{FL}	30	-	70	kHz	9)
FL Input Current per Lamp	I_{FL}	5.5	6.1	8.0	mA(rms)	Per a Lamp 7) 8) 9)12)
Input Low Level	V_{IL}	0	---	0.7	V	3) 4)
Input High Level	V_{IH}	2.2		V_{DD}	V	
Input leakage current	I_{IL}	-100	-	-	μA	V_{IL} =0V
	I_{IH}	-	-	100	μA	V_{IH} = V_{DD}

Note 1) The module should be always operated within these ranges. The "Typ." shows the recommendable value.

Note 2) Checked Pin Terminal: V_{DD} , GND (GND : Vss = 0V)

Note 3) Checked Pin Terminal : R0-R7 and G0-G7 and B0-B7,GND (0V),

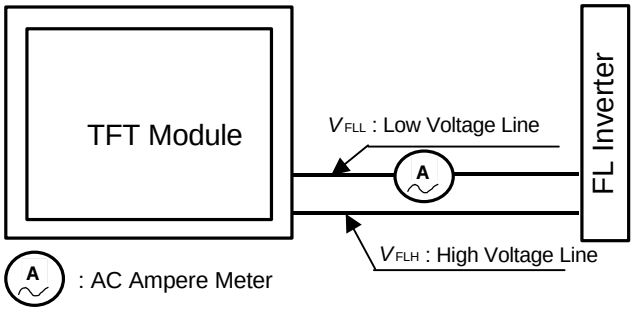
Note 7) Checked Pin Terminal: V_{FLH1}-V_{FLL1}, V_{FLH2}-V_{FLL2}, V_{FLH3}-V_{FLL3}, V_{FLH4}-V_{FLL4}

Note 8) If FL input current is higher than typical value, then FL lifetime become shorter.

Note 9) Measuring Method of I_{FL} :

This TFT-LCD module uses twin FL lamps.

So the measuring value of AC ampere meter is FL input currents of two lamps.



Note 10) Please adjust LCD operating signal timing and FL driving frequency, to optimize the display quality.

There is a possibility that flicker is observed by the interference of LCD operating signal timing and FL driving frequency, even if the condition satisfies above recommended operating condition and timing specification shown in 2.4.4

Note 11) Input FL starting voltage (V_{SFL}) should not be less than one second.

If it were less than one second, it may cause unstable operation of FL.

Note 12) If FL input current is higher than typical value, the deterioration of display quality may be occurred.

Note 13) Inverter should be designed to meet the follow conditions:

(1) The positive and negative waveforms of lamp current and voltage should be symmetric.
The symmetric ratio should be larger than 90%. And the waveform should be approached a sine-curve.

(2) It is recommended to using push/pull type"-inverter. Because the backlight unit of t his LCD-Panel is designed for "push/pull type"-inverter.

(3) Please set the all input voltages (CN2, CN3, CN4, CN5) synchronization.

4. Electrical Characteristics

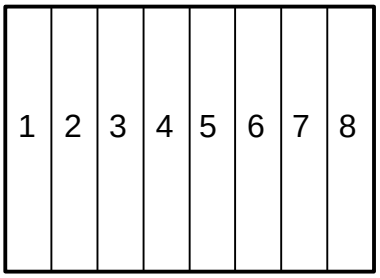
4.1 Test Conditions

Ambient Temperature	: T_a	25±3°C
Ambient Humidity	: H_a	55±15%(RH)
Supply Voltage	: V_{DD}	5.0 V
Input Signal	: "Typ"-value of timing specification shown in 2.4.4	
FL Inverter	: HIU-473 for LTA140C060F (Harison Toshiba Lighting corp.)	
FL Input Current	: I_{FL}	6.0mA(rms) / Lamp
FL Driving Frequency	: f_{FL}	50kHz

4.2 Specifications

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Current Consumption	I_{DD}	-	190	270	mA	V_{DD} Terminal Current

Note 1) The value of I_{DD} is measured in the following pattern.



1. White
2. Yellow
3. Purple
4. Red
5. Light Blue
6. Green
7. Blue
8. Black

5. Optical Characteristics

5.1 Test Conditions

It is same as 4.1

The measuring method is shown in 11.

5.2 Optical Specifications

Item		Symbol	Conditions		Specifications			Unit	Remark
					Min.	Typ	Max.		
Viewing Angle		q	*CR*>=10	f = 180°	50	80	-	°	
				f = 0°	50	80	-	°	
				f = 90°	50	80	-	°	
				f = -90°	50	80	-	°	
Contrast Ratio		CR	q=0°, f=0°		300	400	-	-	
Response Time		t_r	q=0°, f=0°		-	4	10	ms	
		t_f			-	12	20	ms	
Luminance		L	q=0°, f=0° Gray Scale Level=L255 (White)		350	450	-	cd/m^2	
Chromaticity	Red	x_R	Gray Scale Level:L255 q=0°, f=0°		-	0.640	-	-	
		y_R			-	0.330	-	-	
	Green	x_G	Ditto		-	0.300	-	-	
		y_G			-	0.600	-	-	
	Blue	x_B	Ditto		-	0.138	-	-	
		y_B			-	0.060	-	-	
	White	x_W	Ditto		0.220	0.280	0.340	-	
		y_W			0.220	0.280	0.340	-	

Note 1): Refer to "11. Measuring Method".

Note 2) Photometer : BM-5A TOPCON (Aperture 2°)

Note 3): The above test limit must be applied for initial use. Characteristics will be shifted by long period operation, but it is not irregular phenomena. Theoretically brightness characteristics will be decreased due to CCFL degradation and color shift due to optical components change.

6.Quality

6.1 Inspection AQL

Total of Major Defects	: AQL 0.65 %
Total of Minor Defects	: AQL 1.5 %
Sampling Method	: ANSI/ASQC Z1.4 (Level 2)

6.2 Test Conditions

1) Ambient Temperature	: 25±5°C
2) Ambient Humidity	: 65±20% (RH)
3) Illumination	: Approximately 500 lx under the fluorescent lamp
4) Viewing Distance	: Approximately 30cm by the eyes of the inspector from the module
5) Inspection Angle	: q=0°, f =0°

6.3 Dimensional Outline

The products shall conform to the dimensions specified in 2.3.2.

Definition of Major and Minor defects are as follows.

Item	Description	Class
Important Dimensions	Dimensional outline, Dimensional between the mounting holes.	Major
Others	Dimensions specified in this specifications	Minor

6.4 Appearance Test

6.4.1 Test Conditions

1) Condition: Non-operating : PCB Appearance, Soldering, Bezel, Plastic Frame, Connectors

Same as 6.2

2) Condition: Non-operating and operating : Black and White Spots/Lines

Same as 6.2

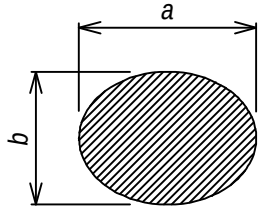
6.4.2 Specifications

<table>
<tr><th>Item</th><th>Description</th><th>Class</th></tr>
<tr><td>PCB Appearance</td><td>Pattern peeling snapping, electrically short</td><td>Major</td></tr>
<tr><td></td><td>Repair portion on PCB is not covered by epoxy resign</td><td>Minor</td></tr>
<tr><td>Soldering</td><td>Cold solder joint, lead move when pulled</td><td>Major</td></tr>
<tr><td>Bezel, Frame, Connectors</td><td>Distinct stain, rust or scratch</td><td>Minor</td></tr>
<tr><td>Spots/Lines[1)2)]</td><td>(Bright Line)
<table>
<tr><th>Line width (mm)</th><th>Length (mm)</th><th>Acceptable count</th></tr>
<tr><td>$W \le 0.01$</td><td>-</td><td>Neglect</td></tr>
<tr><td>$0.01 < W \le 0.10$</td><td rowspan="2">$0.3 \le L \le 1.0$</td><td>$N \le 2$</td></tr>
<tr><td>$0.10 < W$</td><td>[2)]</td></tr>
</table>
(Bright Spot)
<table>
<tr><th>Average diameter (mm)</th><th>Acceptable count/side</th></tr>
<tr><td>$D \le 0.10$</td><td>Neglect</td></tr>
<tr><td>$0.10 < D \le 0.3$</td><td>$N \le 2$</td></tr>
<tr><td>$0.3 < D$</td><td>0</td></tr>
</table>
(Non-Bright Line)
<table>
<tr><th>Line width (mm)</th><th>Length (mm)</th><th>Acceptable count</th></tr>
<tr><td>$W \le 0.01$</td><td>-</td><td>Neglect</td></tr>
<tr><td>$0.01 < W \le 0.10$</td><td rowspan="2">$0.3 \le L \le 1.0$</td><td>$N \le 3$</td></tr>
<tr><td>$0.10 < W$</td><td>[2)]</td></tr>
</table>
Non-Bright Spot
<table>
<tr><th>Average diameter (mm)</th><th>Acceptable count/side</th></tr>
<tr><td>$D \le 0.10$</td><td>Neglect</td></tr>
<tr><td>$0.10 < D \le 0.3$</td><td>$N \le 3$</td></tr>
<tr><td>$0.3 < D$</td><td>0</td></tr>
</table>
(Total Spots and Lines): $N \le 5$</td><td>Minor</td></tr>
</table>

Note 1) Inspection area should be within viewing area.

Note 2) Dusts which are bigger not less than 0.10mm ($0.1 \le W$) shall be judged by "Average Diameter".

Average Diameter $D = (a+b)/2$ (mm)



6.5 Display Quality

6.5.1 Test Conditions

1) Inspection Area : Within viewing area

2) Condition : Same as test conditions shown in 4.1 and 6.2

3) Test Pattern : White display pattern (gray scale level L255) , Black display pattern (gray scale level L0)
Red display pattern (gray scale level L255), Green display pattern (gray scale level L255)
Blue display pattern (gray scale level L255)

6.5.2 Specifications

Item	Description / Specifications	Class
Function	No display, Malfunction	Major
Display Quality [1)2)3)]	Missing line	Major
	Missing Sub-Pixels **1) Bright defects : 5 pcs. maximum [2)3)]** **2) Dark defects : 10 pcs maximum [2)]** **3) Total sub-pixel defects : 10 pcs maximum**	Minor
	Various uniformity (mura) : neglect	
	Inconspicuous flicker, crosstalk, Newton's ring and other defects : neglect [4)5)]	-
Black and White Spots/line	Same as 6.4.2 [5)]	Minor
Backlight	Missing (Non-operating)	Major

Note 1) Defects of both color filter and black matrix are counted as bright or dark defects.
Inspection area should be within the active area.

Note 2) Bright defect means a bright spot (sub-pixel) on the display pattern of gray scale L0.
Dark defect means a dark spot (sub-pixel) on the display pattern of gray scale L255.

Note 3) Bright spot which can not be found by using 5%ND-Filter shall not be counted as a defect.

Note 4) Test pattern : White and black 1dot-checker display pattern (gray scale level L255 and L0),

Note 5) Test Pattern : White display pattern (gray scale level L127), Black display pattern (gray scale level L0)

6.6 Reliability Test

6.6.1 Test Conditions

1) The module should be driven and inspected under normal test conditions.

2) The module should not have condensation of water (moisture) on the module.

3) The module should be inspected after two or more hours storage in normal conditions (15 - 35°C,45 - 65%(RH)).

4) A module shall be used only for one test.

6.6.2 Specifications

The module shall have no failure in the following reliability test items.

Test Item	Test Conditions	Result
High Temperature Operation [1)]	50°C 192 h	OK 3p/3p
High Temperature Storage [2)]	60°C 192 h	OK 3p/3p
High Temperature High Humidity operation [1)]	40°C 90% 192 h	OK 3p/3p
Low Temperature Operation [1)]	0°C 192 h	OK 3p/3p
Low Temperature Storage [2)]	-20°C 192 h	OK 3p/3p
Temperature Shock [2)]	-20°C ⇔ 60°C 1.0h 1.0 h 5 cycles	OK 3p/3p
Mechanical Vibration [2)]	10 - 57Hz half-sine pulse 0.075mm, 57-500Hz, 1.0×9.8m/s^2 , 11min/cycles once for X.Y.Z each directions, 0.5h each	OK 3p/3p
Mechanical Shock [2)]	50×9.8m/s^2 , 11ms, ±X, ±Y, ±Z direction, one time each directions	OK 3p/3p

Note 1) Operating

Note 2) Non-Operating

Definitions of failure for judgment shall be as follows:

1) Function of the module should be maintained.
2) Current consumption should be smaller than the specified value.
3) Appearance and display quality should not have distinguished degradation.
4) Luminance should be larger than 50% of the minimum value. (Refer to 5.2 Optical Specifications)

6.7 Labels

(1) Product Label

unit: mm

Serial number : △△ ▲ 3A 0 00001
① ② ③ ④ ⑤

① : Module type code

② : Manufacturing code

③ : Lot code 3 A
(1) (2)

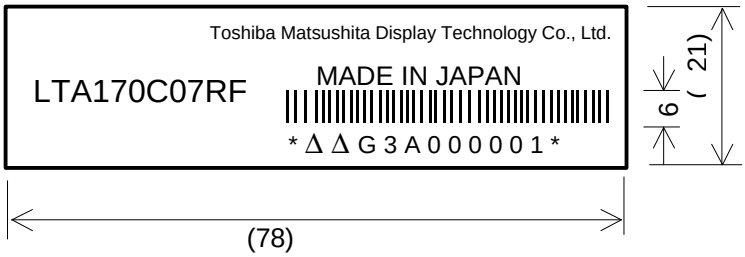
(1):Year code-end of the A. D.

(2):Month code-alphabet

→Jan. : A - Dec. : L

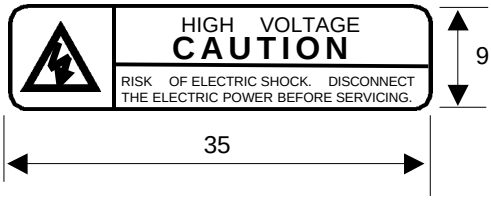
④ : Revision No.

⑤ : Serial code decimal, 5 figures

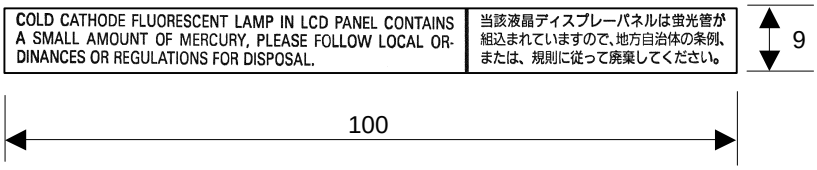


(2) Caution Labels

• High Voltage



• Disposal of CCFL



(3) Label Locations

TBD

A: Product Label

B: Caution Label (High Voltage)

C: Caution Label (Disposal of CCFL)

7. Lifetime

7.1 Module (except lamp)

MTTF (Mean Time To Failure) : 50,000 h

(This value is not assurance time but inference value by following conditions.)

Conditions : Ambient temperature : 25±5°C (No wind)

Ambient humidity : 65%(RH)

7.2 Lamp

7.2.1 Test Conditions

Ambient temperature	: 25±5°C (No wind)
Lamp current	: 6.0mA(rms)/Lamp
Lighting condition	: continuous lighting
Driving frequency	: 50kHz

7.2.2 Specifications

MTBF : 50,000 h

Definitions of failure for judgment shall be as follows.

1) LCD luminance becomes half of the minimum value specified in 5.2.

2) Lamp doesn't light normally.

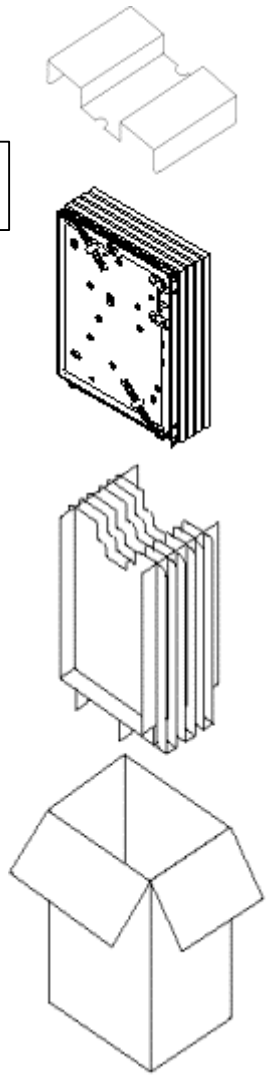
8. Packaging

8.1 Carton (internal package)

(1) Packaging Form

Corrugated cardboard box

TENTATIVE

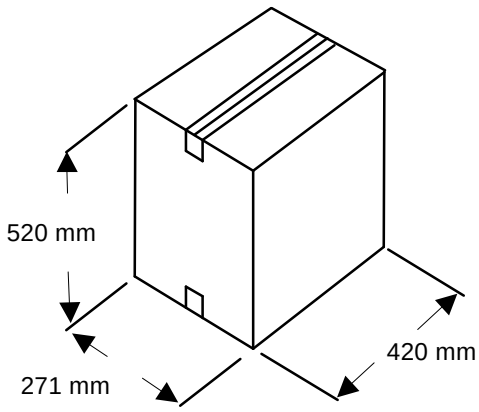


(2) Packaging Method [1) 2)] :

Note 1) : Total weight : (Approx.) 12.7kg
Note 2) : Acceptable number of piling : 12sets

(3) Packaging Material :

Number	Quantity	Description
①	5	Static electricity Protective sack
②	1 set	Holder (inner box)
③	1	Static electric Protective square bag
④	3	Silicagel (100g×3)
⑤	1 set	Carton
⑥		Plastics adhesive tape

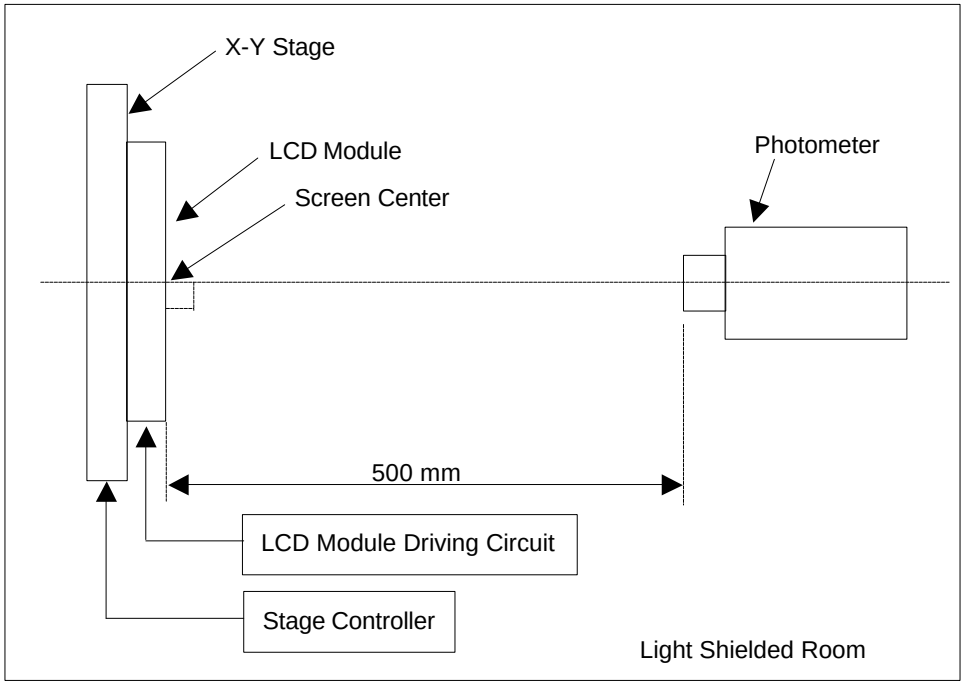


9. Warranty

Finish of warranty term is until arrival at your factory. (except defect which is clearly responsible for Toshiba Matsushita Display Technology Co., Ltd.)

10. Measuring Method

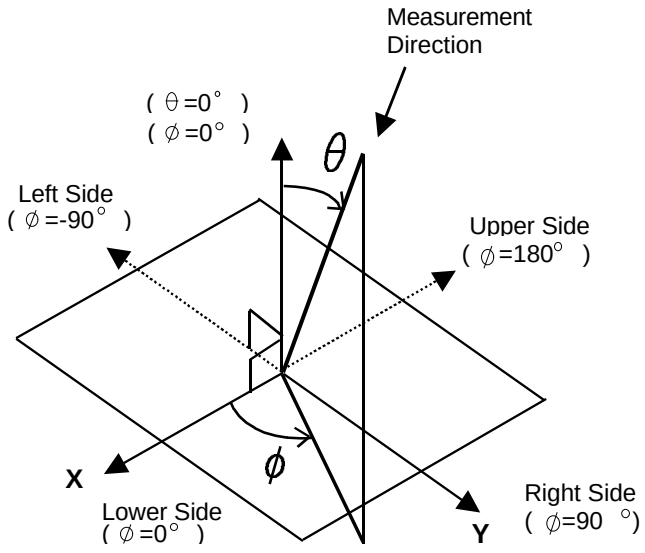
10.1 Measuring System



(1) The measurement point is the center of the active area except the measurement of Luminance Uniformity.

(2) Photometer : BM-7/BM-5A TOPCON (Aperture 2°)

(3) Definition of ϕ and θ :



10.2 Measuring Methods

(1) Luminance:

The luminance of the center on a white raster (gray scale level L255) shall be measured.

Measurement shall be executed 30 minutes after the lamp is lit up.

(2) Contrast Ratio:

The contrast ratio can be calculated by the following expression.

Contrast Ratio (*CR*) = L255 / L0

L255 : Luminance on the white raster (gray scale level L255)

L 0 : Luminance on the black raster (gray scale level L0)

(3) Viewing Angle

Viewing angle is defined as the angles(q,f), in which specified contrast ratio can be obtained.

(Refer to 11.1(3) for the axes.)

Note) Measuring system for Viewing Angle

(a) The measurement point is the center of the active area except the measurement of Luminance Uniformity.

(b) Photometer: Ez Contrast 160R (ELDIM)

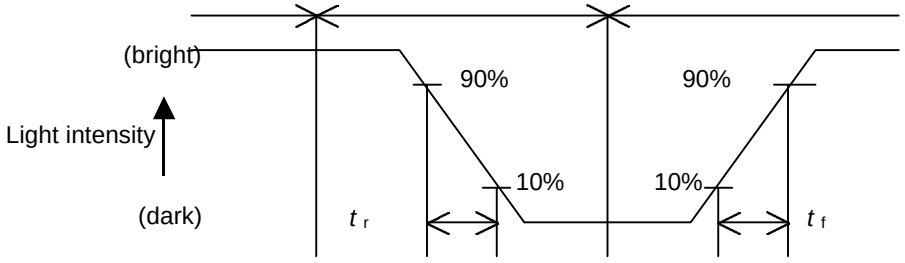
(4) Chromaticity :

The values (x,y) of chromaticity coordinates should be measured for the White, Red, Green and Blue Raster(gray scale level L255) each with a photometer.

(5) Response Time :

The response time is measured using a photo detector (photodiode) which measures the light intensity of the pixels.

Input Signal : All High (White Display) All Low (Black Display) All High (White Display)



t_f: Fall time is the time for the light intensity of the pixels to go from 10% of its maximum to 90% of its maximum.

t_r: Raise time is the time for the light intensity of the pixels to go from 90% of its maximum to 10% of its maximum.

Photodiode : S1223-01 HAMAMATSU PHOTONICS K.K.

White Display : White Raster (gray scale level L255)

Black Display : Black Raster (gray scale level L0)